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PATENTS

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Title: Improved Combined Intercropping and Mulching Method

15 This application is a continuation in part of U.S. utility patent application no. 10/683,889 which is a continuation in part of U.S. utility patent application no. 09/752,956, now U.S. Pat. No. 6,631,585 B1.

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BACKGROUND OF THE INVENTION

(1) This application is a continuation in part of U.S. utility patent application no. 10/683,889

5 which is a continuation in part of U. S. utility patent application no. 09/752,956.

(2) My invention generally relates to combined intercropping of, and application of mulch to, commercial field crops. More particularly, my invention is a process in which annuals are planted in the fall to provide a green manure the following spring to intercropped commercial 10 crops. My invention is intended for planters, farmers and gardeners of all specialties, and to all kinds, sizes and complexities of farming enterprises.

(3) 'Intercropping' is generally defined as the planting of a fast growing crop between alternating rows of a slow growing crop. My new method incorporates the commercially successful tillage 15 system of the United States, particularly in the midwestern and prairie states. My method also incorporates the beneficial ecological effect of growing a commercial annual legume with corn, as well as incorporation of an annual green manure crop such as wheat and buckwheat.

(4) My preferred method of intercropping comprises strip cropping corn and soybeans with 20 subsequent application of green manure to the soil, and a layer of mulch upon the top soil surface. My method does not require pesticides, herbicides or artificial fertilizers for healthy crops, or to obtain an effective ground cover and subsoil root network with an effective moisture canopy and windbreak.

25 (5) Moreover, my invention provides a kindler developmental period for both soybean and corn seedlings through its microclimate effect. Annual green manure plants such as buckwheat remain uncut until tillage and seeding of the commercial crop in early spring. Green manure provides nutrients for a seedling commercial spring crop, as well as a welcome mulch ground cover during the early growing season. My treated soil also accumulates soil nutrients with

yearly use, thereby increasing land productivity. Tilling soil more than once a year may expose soil to air and decreases nutrients and fallow soil. As a result, tilling soil and leaving it without a mulch covering is discouraged.

5 (6) Green manure plants combined with organic residue from deceased crops contains dessicated soybean roots and nitrogen nodules which remain intact in the soil. During the winter months, the intact root systems of these nonviable soybean and corn (and viable wheat) also function as ground cover and subsoil root retention system. In this manner, intact soybean and corn roots provide a physical soil network for the no till planting of a green manure crop (for example wheat
10 grass) in the fall or early spring as the case may be. For example, wheat grass is planted in the fall or early spring, and is subsequently tilled into the soil as green manure while green and viable.

15 (7) The farmer synchronizes planting (seeding) of the intercropped commercial plants with tilling the green manure plants into the soil. My process also provides: a reliable source of soluble nitrogenous and phosphorus compounds in the soil, additional humus and retention of soil, and an economical growth with cutting of green manure for a mulch covering.

20 (8) U.S. Pat. No. US 6,331,585 B1(Williams) discloses an intercropping method in which soybeans are seeded within corn in an alternating predetermined pattern over an entire field. This method is adjustable to other crop and legume combinations, as well as larger commercial sized operations and small home gardens and fields. For best results the corn and soybeans are seeded at the same time in early May. The corn and soybeans subsequently create a micro-climate of humidity, as well as a comprehensive root system and ground cover. These features ameliorate
25 drought and erosion during the entire year. Another advantage is use of conservation tillage which augments ecological long term advantages of intercropping commercial annual grains and

legumes. However, no particular prior art farm implements or mulching step are provided for this intercropping method.

(9) There are prior art approaches to planting annual grain crops in a single growing area. U.S.

5 Patent 5,140,917 (Swanson) describes a method and apparatus for seeding agricultural crops.

Using this method, seeds are placed in residue free rows which are closely aligned with bands of deeply placed fertilizer. The plants from each seed are claimed to access more than one deep band of fertilizer. There is no intercropping component to Swanson's model, and Swanson requires increased fertilizer and seed costs for optimum results.

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(10) European Application 0132521(Hilmer) describes intercropping with two or more crops on one piece of land per seasonal growing year. Hilmer used a grass/grain cluster/per row or a modular cluster row planter upon a slope contour.

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(11) U.S. Pat. No. 4,084,522(Younger) describes a method by which soybean seeds are sown into a standing grain crop (e.g. wheat). When the grain crop is ripe, it is harvested at a height which is slightly greater than the height of the partially grown soybeans. Unlike my process, however, in Younger's model the wheat is planted first, while corn and soybeans are planted considerably later during the same growing season. Moreover, there is no specialized seed application in

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Younger's method.

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(12) U.S. Pat. No. 6,009,955 (Tarver III) is based upon the size and shape of furrows created by a modified harvesting machine. The planter creates these furrows just prior to planting or during the planting season. The Tarver invention compresses the furrow shape just prior to or during planting, to eliminate uneven soil. Koch describes corn planted in 30-inch rows with application of insecticides and liquid nitrogen fertilizer. There is a legume ground cover such as vetch or clover. According to this report, clover did not demonstrate potential as a perennial cover crop.

Phillip Koch, "Legume Cover Crops for No-Till Corn" in J.F. Power, THE ROLE OF LEGUMES IN CONVERSATION TILLAGE SYSTEMS (1984).

(13) Decker et al. describes winter legume cover crops which were seeded after fall corn harvests, and which were allowed to grow until corn planting the following spring. His results indicated that fall-seeded legumes at least partially replace artificial nitrogen fertilizers for maximum corn yields. A.M. Decker et al., "Fall Seeded Legumes' Nitrogen Contributions to No-Till Corn Production," in J.F. Power, *supra*.

(14) Holderbaum reported results in which legumes were grown prior to corn, but later during the same growing season. In this model the legumes were clover and rye grass. According to this investigation, subsequent corn grain yields were highest when the cover crop was not removed. J.F. Hauderbaum et al., "Forage contributions for winter legume cover crops in no-till crop production," in J.F. Power, *supra*.

(15) Scott and Burt reported intercropping red clover into corn seedlings when the corn seedlings were approximately six to twelve inches high. The scientists applied chemical herbicides to the seedlings during this investigation. According to Scott and Burt, they consistently obtained good crops by cultivating corn in 30- inch intercropped rows. High corn yields also consistently

occurred following the plowdown of one year of red clover hay. Scott and Burt concluded that red clover or other legume establishment by intercropping into corn might become a beneficial management approach for nitrogen replenishment, organic matter addition and reduced erosion.

T.W. Scott and Robert F. Burt, "Use of Red Clover in Corn Polyculture Systems," in J.F. Power, *supra*.

(16) Paudey and Pendleton reported the planting of corn seed in 1.5 meter rows with corn seedlings spaced approximately 17 centimeters apart. Three rows of soybeans were planted

between single rows of corn. The investigators applied herbicides and pesticides to the seedlings during the experiments. Forty-two days after planting, the two most exterior soybean rows were plowed into the cornrows in a traditional 'hilling up' procedure. R.K. Paudey and J.W. Pendleton,

"Soybeans as a Green Manure in a Maize Intercropping System," EXPERIMENTAL

5 AGRICULTURE 22:178-85(1986).

(17) Eadie et al. reported the effect of cereal cover crops upon weed control. The investigators hand planted cereal seed within plots which were approximately 2.3 meters wide and 8.0 meters long. The rows were approximately 0.75 meter equidistantly spaced. These investigators seeded

10 the cereal cover crops immediately after the ridging cultivation at the 11-12 leaf stage of corn plants. According to the Eadie report, corn grain yields remained unchanged by cover crops seeded at the 11-12 leaf stage of corn, compared to bare soil treatment controls. Allan G. Eadie et al., "Integration of Cereal Cover Crops in a Ridge-Tillage Corn Production," WEED TECHNOLOGY 6 (3) (July-September 1992).

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(18) Lesoing and Francis stripcropped corn and soybeans to reduce erosion in eastern Nebraska from 1988 to 1990. Corn and soybeans were no-till planted in a north-south orientation in alternating 6.1 meter wide strips (eight rows, 0.76 meter between rows). Each row was approximately 46 meters in length, and each experimental planting areas comprised approximately 280 square meters. Lesoing and Francis planted corn seed at a density of approximately 66,250 seeds/ha. Between the corn strips they planted soybean seedlings in strips of eight rows at 475,000 seeds/ha.

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(19) According to this study, corn border row yields next to soybeans increased significantly compared with interior rows. These scientists suggested that water stress, light quality and shading are among the factors which affect crop yields at different stages of crop development.

Gary W. Lesoing and Charles A. Francis, "Strip Intercropping Effects on Yield and Yield Components of Corn, Grain, Sorghum and Soybean," AGRONOMY J. 91: 807-13(1999).

(20)At least one farmer has reported that closer planting in rows results in more equitable

5 distribution of sunlight, soil moisture and nutrients. NO TILL FARMER (mid-January 1986).

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SUMMARY OF THE INVENTION

(21) My improved combined intercropping and mulching method includes an original approach to intercropping soybeans and corn in a conservation tillage system, but also includes other

5 intercropping combinations of commercial crops. After blending of combined green manure and organic debris into the soil, the farmer seeds corn and soybeans simultaneously at soil temperatures of at least sixty degrees Fahrenheit (F.). The farmer then seeds the intercropped plants, and covers the seeded soil with remaining mulch made of the remaining combined 10 chopped organic debris and green manure plants. Growing seedlings generate leaf canopies which choke weeds, thus decreasing the need for artificial chemical herbicides. Corn roots intertwine with soybean roots to generate an interwoven root system which holds soil in place.

(22) Vertical layers of the crop leaf canopy also demonstrate a shading effect on soil, thereby increasing surface moisture, eliminating sun bleaching and cracking, and lowering soil

15 temperature. The leaf canopy has an anti-erosion effect by slowing and diverting rain and irrigation moisture through the soil.

(23) My invention also comprises the process of planting fields or gardens, in alternating rows or in other configurations, with two or more kinds of other commercial crops and legumes. In the

20 preferred embodiment and best mode, the predetermined alternating rows and areas comprise corn and soybeans. Each crop can be in straight lines, or in curved or convoluted alignment, according to area geography.

(24) In the preferred mode and best embodiment, soybeans are spaced a predetermined distance

25 from each other and each adjacent corn row. In other embodiments, conventional cash crops such as corn and buckwheat alternate with plants such as Queen Anne's lace, vinegar weed, Pennsylvania smartweed or cornflowers. Sweet clover and annual grass are also candidates. Other possibilities, although not exclusively, include corn and potatoes, corn and peanuts or

peanuts and soybeans. The alternating configuration of crops and other appropriate plant species also provides protection against insect pests. Insects can no longer eat from one side of a field to the other, because other selected crops become ecological barriers. Moreover, by using my new planting process, edible yields are greater for the same two dimensional or three dimensional
5 section of a field or garden.

(25) Intercropping also comprises the growth of quick-maturing vegetable crops between slower developing crops, to maximize available garden or field space. For example, soybeans are planted in spring or summer at 2 to 3 pounds of seeds per 1,000 square feet in traditional commercial
10 situations. Soybeans are annuals and must be re-seeded every year; however, they tolerate poor drainage well, and are ideal for nitrogen fixation. Plants such as adzuki and muny beans are fairly resistant to insect pests.

(26) My process differs from the prior art because, although soybean pods and leaves are harvested early in fall, in my process the soybean roots and nitrogen nodules are left intact in the field. These roots and nodules provide a base for a no-till planting of a green manure crop. This intact system also provides a ground cover and subsoil root retention system during the winter months and following spring planting. Green manure is typically tilled into the soil in the spring with conventional farm machinery or hand implements, as the case may be. My process also
20 differs because growing green mature plants are harvested and stored just prior to tilling and planting. The green manure is then reapplied to the soil as mulch after planting.

(27) My improved method of planting commercial crops is synchronized with tilling and harvesting a portion of green manure which blends with field organic debris from previous crops.
25 Green manure is dispersed through each row of corn and soybeans. The combined green manure then provides a mulch for a newly planted field. In the preferred embodiment and best mode of my method, each crop lies within straight rows, curved, or convoluted alignment, as required by

the geography of the planting area. Also in the best mode and preferred embodiment, soybeans are spaced a predetermined distance from each other and adjacent cornrows. Corn roots interact with soybean roots and nodules to a depth of approximately four feet, while soybean stems wind around cornstalks.

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(28) In another embodiment and mode, alternating an appropriate third plant species protects against insect pests by mixing seed of similar sizes, such as soybeans and buckwheat. Preferably the farmer adds buckwheat seed to both corn seeds and soybean seeds just prior to planting, and as the seed drill and corn hoppers are filled with each of the two seed mixtures. Most preferably, 10 the farmer would add approximately 10% by volume buckwheat seed to the soybean or corn seed hopper. Mixing occurs by a seed drill attachment for small seed and then alternating the third crop seeding within each 21-inch wide row with soybeans. As the buckwheat dies in midsummer, the corn and soybean roots adsorb phosphorus left by decomposing buckwheat plants. By fall when the corn and soybeans are harvested, the buckwheat grain should be absent in the fields.

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(29) In other models, intercropping with a third plant species, such as Pennsylvania smartweed, is particularly beneficial because insect pests prefer smartweed to corn and soybeans. The seed drill for planting soybeans, described *infra*, can deposit two different seed sizes simultaneously in the same row (such as soybeans and smartweed).

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(30) My invention also includes the use of prior art machines in new combinations, sequences and modifications. These changes decreases the labor, time, and amount of equipment required to till, simultaneously seed more than one crop in one pass, and mulch an intercropped field. By using my method with machinery in which the farmer has already invested, and with which he is 25 familiar, the farmer finally has an incentive to intercrop his fields because there is no increased time, labor and machinery fuel and maintenance for a long-term commercial crop.

(31) Consequently, one goal of my improved intercropping method is to prevent desiccating winds from harming crops and soil.

(32) Another goal of my improved combined intercropping and mulching method is to insure that 5 soil contains sufficient soluble nitrogenous and phosphorus compounds.

(33) Another object of my combined intercropping and mulching method is to adapt my soybean and corn embodiment to an economical model for either large-scale or more modest agricultural units.

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(34) Another goal of my combined intercropping and mulching method is to add ground cover to fields which are generally uncovered and fallow.

(35) Another goal of my combined intercropping and mulching method is to decrease soil 15 exposure to air, erosion from sun, wind and running water.

(36) Another goal of my process is to incorporate the commercial advantages of present day tillage with ecological benefits.

20 (37) Another goal of my process is the annual quick tilling and planting of crops to decrease nutrient loss.

(38) Another goal of my process is to eliminate sun-bleached soil.

25 (39) Another goal of my process is to integrate conventional farm machinery into an intercropping and mulching process which does not require additional time, labor, fuel or investment.

(40) These and other improvements will become apparent from my detailed description and drawings of my invention.

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BRIEF DESCRIPTION OF THE DRAWINGS

(41) Figure 1 illustrates a lateral view of a field in late fall after harvest and cutting of commercial crops and just prior to planting wheat and buckwheat.

(42) Figure 2 illustrates a lateral view of a field in late fall after harvest of commercial crops with wheat and with buckwheat seed as a no-till planting over cornstalks and soybean stubble.

10 (43) Figure 3 illustrates a lateral view of a field in early spring just prior to mowing of green manure plants, corn stalks and soybean stubble.

(44) Figure 4 is a lateral view of mowed wheat grass and resulting in a twenty foot path prior to tillage, and with adjacent unmowed wheat grass.

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(45) Figure 5 illustrates soil treated by a first tilling machine in a twenty-foot width with adjacent wheat grass on each side of approximately twenty-foot width.

20 (46) Figure 6 illustrates the soil of Figure 5 treated by a second tilling machine to a greater depth within a twenty-foot field width.

(47) Figure 7 illustrates soil of Figure 5 treated by a third tilling machine to a final greatest depth within a twenty-foot width path, and with adjacent unmowed wheat grass.

25 (48) Figure 8 illustrates conventionally plowed soil with non-decomposed organic debris under the soil in a single crop field.

(49) Figure 9 illustrates an anterior view of a prior art twenty-foot wide seed drill with prior art uniform horizontal distances between adjacent equidistantly spaced tru-vee openers.

(50) Figure 10 illustrates an anterior schematic view of the modified seed drill of Figure 9 with

5 eight sets of re-aligned tru-vee openers.

(51) Figure 11 illustrates a post-tilling twenty-foot path intercropped with corn seeds and soybean seeds.

10 (52) Figure 12 illustrates an isolated partial lateral view of a modified seed drill.

(53) Figure 12A illustrates a schematic anterior view of tru-vee openers with fork positions and attachments.

15 (54) Figure 12B illustrates an isolated schematic view of the fork lift attachment and adjustment of the forks.

(55) Figure 13 illustrates a top plan schematic view of a modified seed drill moving forward over a field with a corn planter posteriorly hitched to the tractor.

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(56) Figure 13A is an anterior schematic view of the modified seed drill and how tru-vee opener spacing is modified to form sets.

(57) Figure 14 illustrates a lateral isolated view of the seed drill of Figure 10 with fork lift

25 attachment and hydraulic lifts, tractor and prior art corn planter.

(58) Figure 15A illustrates a close up isolated anterior view of fork lift attachment and modified seed drill.

(59) Figure 15B illustrates an isolated schematic posterior view of the adjustment of seed drill

5 row cover units.

(60) Figure 16 illustrates combination mulch which covers the soil of intercropped maturing soybeans and corn.

10 (61) Figure 17 illustrates a cutaway perspective view for assembly of a bale chopper and forage box wagon with attached exhaust hose.

(62) Figure 18 illustrates a lateral view of a prior art forage box wagon with unload augers exposed.

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(63) Figure 19 illustrates a lateral cutaway view of the assembled forage box wagon and bale chopper of Figure 17.

20 (64) Figure 20 illustrates a lateral view of the bale chopper and forage wagon with attached pipe, hose and bunge cords.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT,
BEST MODE, AND OTHER EMBODIMENTS AND MODES

Introduction

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(65) My intercropping and mulching method 110 resolves the long-felt need to intercrop economically while preserving the soil for the long term. In the best mode of my process 110, the following comprises in most basic format, without additional artificial pesticides, fertilizers and herbicides:

15 (i) no-till planting of green manure plants 44a during the fall within soil 45 of a predetermined area which contains organic debris 19,

(ii) harvesting a portion of the green manure plants 44a for mulch 20;

(iii) quick tilling a portion of green manure plants 44a and organic debris 19 into the soil 45 of this predetermined area the following spring, and

20 (iv) intercropping of commercial crops, including at least one legume, immediately thereafter within the same predetermined soil, and

(v) spreading a layer of combination mulch 20, also comprising green manure plants 44a and organic debris 19, over the surface of the intercropped seeded soil 45.

25 (66) Green manure plants 44a are no-till seeded during the previous fall, or spring of the following commercial planting season. The farmer next mows green manure plants 44a and plant debris 19, which becomes combination mulch 20 and is collected in a forage box wagon 51, *infra*. He then tills soil 45 with a portion of combined green manure 44 approximately nine to 14 inches deep into the same soil 45. After seeding the intercropped commercial crops, the farmer covers

30 soil 45 containing intercropped commercial seeds with combined mulch 20. Combined mulch 20

also comprises plant debris or other organic residue 19 which remains from the fall commercial harvest (such as soybean and cornstalk stubble), along with chopped green manure plants 44a.

(67) For intercropped corn and soybeans, preferably there is approximately one (1) corn seed 10

5 per eight (8) linear inches of soil. This specific seeding in the best mode and preferred embodiment results in approximately five (5) mature corn plants 10c per square yard of topsoil 45a. Soybean seeds 12 are planted at approximately eight (8) to twenty (20) seeds per square foot of topsoil in the best mode. However, in other modes seed concentrations vary outside these ranges.

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(68) My preferred method of combined intercropping and mulching 110 provides best results in a

midwestern climate. The preferred soils are typical of southwestern lower Michigan and northern

Indiana, especially Berrien County in Michigan and LaPorte County in Indiana. Crops are

preferably planted in rimer loamy fine sand soils, above a river or drainage way. Soils such as

15 rimer are easily washed away, so my combined method 101 is particularly useful in these areas.

However, method 101 is also beneficial upon other farmland, as well as irrigated fields.

Intercropping and green manure growth is optimal when soil 45 is planted the previous growing

season with commercial soybeans 16c.

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(69) The seeds for the best mode of my intercropping and mulching method 110 are:

(1) soybean seeds 12, DeKalb variety CX303RR, Lot. No. 1744EJMLA, germ 85;

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(2) corn seeds 10, DeKalb Hybrid DK 567, Lot. No. 1748JXEH, germ 95.

These preferred varieties of soybean seeds 12 and corn seeds 10 are available from:

30 Buchanan Feed Mill, Inc.

P.O. Box 109

Railroad Street

Buchanan, Michigan 49107-1698

(70) Other satisfactory corn seed 10 and soybean seed 12 for my improved intercropping and

5 mulching process 110 are also available from:

Strefling Farms,

Galien, Michigan 49113

10 and

D & S Farms

Galien, Michigan 49113

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Corn seeds 10 are R- Ready Corn®, Variety No. DK 493 R while soybean seeds 12 are 2702

ASGROW® lot number 5371EAAM, ASGROW® Variety No. AG 2702.

(71) The preferred buckwheat and wheat seed is available from:

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Baroda City Mills

8923 First Street

Baroda, Michigan 49101

Lot No. BW-2001

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Planting and harvesting of green manure plants 44a

(72) My preferred method 110 for an intercropped field soil 45 incorporates maturing wheat

plants 17 and buckwheat 18 into combination green manure 44. The farmer begins the process

110 in late summer or early fall after harvest of an earlier commercial crop (preferably corn 10c

30 and/or soybeans 16c) upon pre-selected soil 45. In the best mode the farmer no-till plants wheat

seeds 17b and buckwheat seeds 18b in buckwheat furrows 39. These buckwheat furrows 39 are

positioned among cornstalks 5 and a three inch stubble of soybeans 16 which remain after the fall harvest.

(73) Referring initially to Figure 1, decomposed cornstalks 5 and other organic residue 19 contain 5 droppings from Japanese beetles. Japanese beetles prefer to eat Pennsylvania smartweed instead of corn 10c and soybean plants 16, and their droppings add to organic residue 19. In other modes of method 110, the farmer plants buckwheat seed 18b over previously unplanted fallow soil 45. In these modes, the farmer intercrops buckwheat seed 18b between corn rows 8 in previously 10 fallow soil 45. When he subsequently plants wheat 17 in the fall after mature corn 10c is harvested, there is a green manure 44 which becomes mulch 20 for a single crop of mature corn 10c or soybeans 12.

(74) Sprouting wheat 17 and buckwheat 18 promote soil 45 retention during winter. Although 15 wheat 17 grows slowly over the winter, by spring it is well established and matures quickly, thereby preventing weeds from sprouting. Referring to Figure 2, the farmer can seed buckwheat 18b in the fall, spring or summer at (i) approximately two to three pounds of seed per 1,000 square feet, and (ii) simultaneously seeding commercial intercropped plants such as corn and soybeans. Buckwheat 18 is preferred as a green manure plant 44a, because it tolerates infertile and acidic soils but accumulates phosphorus. By adding buckwheat 18b to wheat seed 17b in the 20 fall as a green manure plant 44a, and replanting buckwheat 18 with corn 5 and soybeans 12 in spring over previously planted wheat 17, there is additional phosphorus for soil 45.

(75) The recommended conventional no-till seeding machine 84 for wheat 17 and buckwheat 18 25 is a CASE 5400 no till grain drill. However, a JOHN DEERE 560 no-till drill, or a JOHN DEERE 1860 no-till air drill are also satisfactory. Referring to Figure 3, by the following spring wheat 17 and/or buckwheat 18 comprise wheat grass 18a which is approximately 14 to 20 inches in height.

(76) The CASE 5400 No-till grain drill for creating furrows 39 and seeding wheat 17 and/or buckwheat 18 is available from:

5 Case Canada Corporation

450 Sherman Ave.

Hamilton, Ontario L8N, 4C5 Canada

or

Case Corporation

10 700 State Street

Racine, Wisconsin 53404

(77) The following annuals are also satisfactory for providing combination mulch 20 and combination green manure 44 for the following spring intercropped planting:

15 (a) Austrian peas, which are seeded in late summer or fall in well-drained soils, and flourish in warmer climates.

(b) Hairy vetch, which is seeded in late summer or fall, with 1-2 pounds of seeds per 1,200 square feet. Hairy vetch tolerates moderate drainage, grows well in northern climates and is a good 20 source of soluble nitrogen soil compounds.

(c) Soybeans, which are seeded in spring or summer, at 2-3 lb. of seed per 1,000 square feet. Soybeans tolerate poor drainage well.

25 (d) Annual rye grass which is seeded in spring at approximately one to two pounds of seed per 1,000 square feet. Annual rye grass tolerates a wide range of soils, provides a quickly placed soil

cover, and subsequently provides sufficient nutrients for a slow growing commercial crop such as fruit trees, grape vineyards, berry fields, watermelons and tomatoes.

(e) Winter rye which is seeded in late summer or fall at approximately two to three pounds of seed per 1,000 square feet. Winter rye prefers well drained soils, but it is also very winter hardy

5 and grows well in early spring.

Production of combined green manure 44

(78) Referring to Figure 3, wheat grass 18a (consisting of the upper portions of young wheat 17 and/or buckwheat 18 plants) remains viable until it is mowed immediately prior to spring tilling.

10 The top approximate one-half of wheat grass 18a is chopped and blended with organic debris 19 to become combined mulch 20, as explained in more detail *infra*. The remaining approximately one-half of the bottom portions of green manure plants 44 (such as wheat grass 18a), is tilled into soil 45 with organic debris 19 prior to spring seeding of intercropped commercial plants.

15 (79) Referring to Figure 4, in the preferred embodiment and best mode the farmer mows wheat grass 18a, residual corn stalks 5 and organic debris 19 approximately three inches to ten inches above soil 45. The determination of the exact height of mowed wheat grass 18a to properly cover soil 45 is empirical. This determination also depends upon leaf density of wheat grass 18a. Leaf density primarily depends upon nutrients in the soil, weather conditions, and time of the 20 year, including the required 60 degrees Fahrenheit (F.) soil temperature. Consequently, each field has a different leaf density and different plant heights.

(80) Buckwheat 17 is generally mowed along with wheat grass 18a. However, buckwheat 17b can be reseeded with corn 10 and soybean seed 12 for a summer planting, to produce additional 25 nutrients. Please see Figure 11. The recommended conventional machine for mowing wheat grass 18a, residual cornstalks 5 and residual soybean 16 stems (thereby creating combined mulch

20) is prior art INTERNATIONAL 650 Forage Harvester. This particular mowing machine comprises a cutting bar unit and is available from:

International Harvester Company

5 401 North Michigan Avenue

Chicago, Illinois 60611

(81) INTERNATIONAL 650 Forage Harvester mows, rakes and collects mowed green manure plants 44a and organic debris 19 for a lateral distance 101 of approximate twenty feet across a field. INTERNATIONAL 650 Forage Harvester simultaneously mows and blows upper portions 10 of wheat grass 18a into towed forage wagon 51, for storage prior to mixing and chopping within bale chopper 108, *infra*. INTERNATIONAL 650 Forage Harvester both mows and collects wheat grass 18a for larger commercial fields, while conventional small mowing and gathering tools are satisfactory for gardens and small fields.

15 (82) A 5460 or 5440 Forage Harvester with mower bar unit is also satisfactory, as well as other farm machinery for cutting and collecting mowed wheat grass 18a. Forage Harvesters are self-propelled forage harvesters 50 from John Deere, Inc. With a 5460 or 5440 Forage Harvester the farmer mows an approximately 20 feet wide interval of wheat grass 18a in the first step of 20 process 110. However, Forage Harvesters can only collect a portion of the mowed wheat grass 18a within a twenty-foot wide path, so two passes may be necessary.

(83) The farmer mows this twenty-foot wide path across the field in an east/west direction and then tills the same twenty-foot wide path prior to intercropping. Later during the growing season, 25 sunlight falls between rows, and the tall crop (such as corn) does not shade the shorter crop (such as soybeans). After mowing and raking, in other modes the farmer deposits organic fertilizer into soil 45, such as animal manure or minerals such as lime.

Tilling of combined green manure 44 into soil 45

(84) Immediately after mowing of the first twenty-foot width 101 of wheat grass 18a, the farmer quickly tills soil 45 with organic residue 19 (such as cornstalks 5) and a three-inch stubble of remaining soybeans 16, along with a portion of wheat grass 18a. Figure 5. A preferred

5 conventional machine 58 tilling is the 3800 series field cultivator for larger commercial fields from:

AGCO® GLENCOE®

4205 River Green Parkway

10 Duluth, Georgia 30096

1-800-767-3221

or

Kuhn EL 201/400

5390 East Seneca Street

15 Vernon, New York. 13426-0840

(85) For larger commercial fields, the most preferred power tilling machines are available from:

Kuhn Farm Machinery, Inc.

5390 East Seneca Street

Vernon, N.Y. 13476-0840

20 Phone: 1-315-829-2620

Models: EL35, EL50, EL80N, EL100N, and EL 140N

and are distributed by:

H.F.S. Tractor

Barode, Michigan 49101 and Niles, Michigan 49120

(86) The farmer uses a cultivator to till weeds under soil 45 between maturing commercial intercropped plants, and so the cultivator blades are shaped with different working widths than those of tilling machines. Referring to Figure 8, less preferably a plow turns soil 45 to destroy 5 weeds, or to even and break soil 45 prior to planting commercial crops. However, a large tilling machine is more efficient than a plow, in part because tilling machines disk and level soil simultaneously.

(87) In the best mode and preferred embodiment for larger fields, a power tilling machine tills and blends soil 45 and combination green manure 44 to a depth of approximately nine (9) to 10 fourteen (14) inches. Most preferred devices are consecutively moving power tilling machines which blend combination green manure 44 with soil 45 at a greater depth with every pass (i. e., one unidirectional trip across the pre-selected field). As seen in Figures 5, 6 and 7, most preferably remaining roots 25 are tilled at a progressively greater soil depth by consecutive tilling machines.

15
(88) In smaller areas, a gardener uses a conventional manual garden tiller to evenly disperse combined green manure 44 throughout soil 45. In smaller areas, the gardener only tills sufficient soil 45 to plant two corn rows 8 and then deposit soybean seeds 12 within a predetermined soybean area 9 between corn rows 8. By running the conventional tiller over the same area three 20 times, the gardener achieves the desired blended soil 45 and combined green manure 44 consistency. Rototillers for smaller fields are available from:

Troy-Bilt Rototillers
P.O. Box 368023
25 Cleveland, Ohio 44136
1-330-273-4550,

and are also distributed through:

H.F.S. Tractor

1218 South 11th St.

Niles, Michigan 49120

5 (89) For attachment to smaller tractors 97, there is the AG side shift rotating tiller from:

Celli S.p.A.

Via Zignola,2/B

47100 Forli,

10 Tel (0543) 754145

(90) A rototiller (for smaller areas), garden tiller (for smaller areas) or power tiller is superior to merely layering organic debris 19 with a plow. Referring again to Figure 8, a prior art plow merely cuts soil 45 and 'flips it over,' and consequently organic debris 19 may not decompose by the next spring planting season. My new method 110 uses tillers for this step, and thereby

15 decreases fertilizer requirements. Method 110 also evenly disperses combined green manure 44 throughout the soil, thereby creating additional air spaces for new plant roots.

(91) Consecutive use of three power tilling machines also allows each attached tractor 97 to follow the other as closely as possible. Three power tilling machines can also overlap in an east/west direction for optimal sunlight. Moreover, one large power tilling machine tills an 20 approximately thirteen feet pass width (i.e, perpendicular to direction of tractor 97 movement). By simultaneously using three tilling machines the farmer overlaps each pass for approximately a seven-foot width.

(92) A twenty-foot wide path (or pass) 101 comprises approximately eight thirty-inch wide corn rows 8, between which the farmer can plant approximately seven twenty-one inch wide 25 alternating soybean area/rows 9 (and one row 9 extending past eighth corn row 8). However,

other crops can also be planted in this particular intercropping pattern, and/or the intercropping pattern can comprise different widths.

One-Step Seeding of Intercropped Commercial Plants

Introduction

- 5 (93) In the best mode of my invention 110, a conventional seed drill 96 is modified to plant an approximately 21-inch wide area 9 of soybean seeds 12, between linearly planted corn seed 10. The modified seed drill 96 preferably leaves alternating intervening unplanted areas 8b which are then seeded with a conventional corn planter 95.
- 10 (94) For large fields, the following machinery is preferred for seeding intercropped commercial plants immediately after tilling and blending combination green manure 44 with soil 45:
 - (i) General utility tractors 97 such as WHITE 6105 midsize tractors from:
AGCO® WHITE
4830 River Green Parkway
Duluth, Georgia 30136
 - (ii) Corn seed planters 95, such as KINZE® 3000 series planters, and which are available from:
KINZE® Manufacturing, Inc.
- 15 I-80 at Exit 216
Williamsburg, Iowa 52361-0806
- 20 (95) Other satisfactory corn seed planters 95 include SUNFLOWER® Series 9000 Grain Drills, which are available from:
 - 25 Sunflower Manufacturing Co., Inc.
P.O. Box 566
#1 Sunflower Drive

Beloit, Kansas 67420

1-800-748-8481

and John Deer model NO. 1720 MaxEmerge®PLUS Planters.

(iii) Recommended seed drills 96 for soybean seeds 12 are available from:

5 John Deere, Inc. distributors,

and

Sunflower Manufacturing, Inc.

P. O. Box 5566

#1 Sunflower Drive

10 Beloit, Kansas 67420

Phone: 1-800-748-8481

Satisfactory Series 9000 grain drills 96 are also available from Sunflower Manufacturing Co., Inc. for this same purpose.

15 (96) In my invention each corn furrow 90 is located within a corn row 8, and two consecutive corn furrows 90 are approximately 30 inches laterally apart. However, the prior art unmodified JOHN DEERE 520 seed drill 96 of Figure 9 fails to provide separate growth areas for each crop. Referring to Figure 10, with method 110 the farmer preferably uses a modified JOHN DEERE 520 seed drill 96 for soybean seeds 12. The farmer can then sow soybean seeds 12 within an 20 approximately twenty-one inch wide area 9 which is centrally located within a previously designated corn row 8. Each corn furrow 90 is approximately four inches deep and linearly deposited corn seeds 10 are placed approximately eight (8) inches apart.

(97) Referring to Figure 11, each soybean area 9 contains three subrow 9a, 9b, 9c, with 9b 25 centrally located subrow within each set of three such subrows. The distance between each lateral subrow 9a, 9c (i.e., adjacent to central subrow 9b) and central subrow 9b (i.e., in the approximate

center of corn row 8) is approximately seven inches. Within a twenty foot wide path there are eight corn rows 8 with eight 21-inch wide areas 9 (each containing three subrows 9a, 9b, 9c) within seven of the eight corn rows 8. One set of three seven-inch subrows 9a, 9b, 9c extends beyond the eighth corn row 8.

5

Adjustment of tru-vee openers 150, 153 for seeding subrows 9a, 9b, 9c

(98) To create the seeding pattern of Figure 11, a prior art seed drill 96 such as the preferred JOHN DEER 520 seed drill must comprise tru-vee openers 150, 152, 153 and row cover units 160. The prior art random distribution of soybean seed 12 (within an approximately 20 foot wide path) by a seed drill 96 is not a disadvantage for single crop fields. In contrast, to effectively intercrop two crops in an alternating pattern my modified seed drill 96 is adjusted to seed three subrows 9a, 9b, 9c of soybean seeds 12 within two linearly aligned corn furrows 90 during one pass. In this best mode and preferred embodiment, three consecutive subrows 9a, 9b, 9c form a single approximately 21-inch wide soybean area 9 within each consecutive 30-inch wide corn row 8.

15

(99) Tru-vee openers 150, 152, 153 are features of prior art JOHN DEER 520 seed drill 96. Referring to Figure 9, conventionally each such tru-vee opener 150, 152, 153 is uniformly either seven inches or ten inches from an adjacent tru-vee opener 150, 152, 153 along horizontal opener draw bar 147. Each tru-vee opener 150, 152, 153 deposits soybeans seeds 12, and also comprises a posterior attached row cover unit 140 to cover each soybean subrow 9a, 9b, 9c with soil 45.

(100) Referring now to Figure 10, the preferred modified seed drill 96 is approximately twenty feet in width. The linear distance along opener draw bar 147 from right exterior edge 160a to drill center frame 149 is approximately ten feet, as is the distance between left exterior edge 160b and drill center frame 149. On either side of drill center frame 149 are four sets 151 of three tru-vee openers 150, 152, 153. Each tru-vee opener 150, 152, 153 opens soil 45 with first and second

disk blades 154a, 154b. Blades 154a, 154b are angled to each other, thereby forming a "v" with an apex at the point closest to soil 45. As tru-vee openers 150, 152, 153 move forward, blades 154a, 154b turn and cut into soil 45, creating a v-shaped indentation. A seed tube is positioned centrally between both blades to deposit seeds within each v-shaped soil indentation.

5

(101) As seen in Figures 12, each tru-vee opener 150, 152, 153 within set 151 attaches to opener draw bar 147 by first and second bolts 150a, 150b respectively. In turn, bolts 150a, 150b attach to opener draw bar 147 by first, and second drill nuts 120a, 120b respectively, with first and second drill washers 130a, 130b respectively. Drill nuts 120a, 120b and washers 130a, 130b must be

10 removed together with bolts 150a, 150b, to move each tru-vee opener 150, 153 horizontally along opener draw bar 147.

(102) As seen in Figures 10 and 12, third frame 148 lies above tru-vee openers 150, 152, 153, and comprises opener springs 170. Third frame 148 holds each opener spring 170 in place above each

15 corresponding tru-vee opener 150, 152 or 153, as the case may be. Each opener spring 170 presses downward on its corresponding tru-vee opener 150, 152, 153, thereby providing stabilization over a hard soil surface. Each opener spring 170 presses its corresponding tru-vee opener 150, 152, 153 into soil 45 in the same manner as prior art seed drills.

20 (103) Referring to Figures 10 and 12, each opener spring 170 also has an upper U-clamp 180 which attaches each opener spring 170 to third frame 148 with first and second nuts 150c, 150d respectively. When nuts 150c, 150d and bolts 150a, 150b are removed, a person can manually

25 slide each tru-vee opener 150, 152, 153 horizontally along oepner draw bar 147 and third frame 148. Each tru-vee opener 150, 152, 153 also comprises a single seed tube 158 which connects

each corresponding tru-vee opener 150, 152 or 153 to seed bin 159 in a manner well known in the agricultural industry.

(104) Referring now to Figures 10 and 13A, each set 151 of tru-vee openers comprises a first tru-vee opener 150 which is most interiorly positioned for each particular set 151 (i.e, first true-vee opener 150 is closest to center frame 149 within each set 151). To adjust seed drill 96 for three subrows 9a , 9b, 9c (in which first lateral subrow 9a and second lateral subrow 9c are each approximately seven inches from central subrow 9b) the farmer first removes bolts 150a, 150b, nuts 120a, 120b, 150c, 150d and washers 130a, 130b from each first tru-vee opener 150.

(105) The farmer then slides each first tru-vee opener 150 (along opener draw bar 147 and third frame 148) three inches closer to adjacent second tru-vee opener 152 (also located on opener draw bar 147). Each first tru-vee opener 150 is now approximately seven inches from the more exteriorly located adjacent tru-vee opener 152. As seen in Figure 13A, each first tru-vee opener 150 is also now closer to first or second opener draw bar exterior edge 160a, 160b respectively, as the case may be.

(106) The farmer replaces bolts 150a, 150b, with nuts 120a, 120b and washers 130a, 130b for each relocated first tru-vee opener 150. To tighten each first true-vee opener 150 in its new position, the farmer replaces bolts 150a, 150b through opener draw bar 147. He also replaces washers 130a,130b on bolts 150a, 150b, and tightens drill nuts 150c, 150d which hold each U-clamp 180 to third frame 148.

20

(107) Still referring to Figures 10 and 13A, second tru-vee opener 152 within each set 151 requires no adjustment and comprises the middle tru-vee opener 152 for seeding each central subrow 9b within a 21 inch wide soybean area 9. However, each third tru-vee opener 153 is most distant (within its set 151) from center frame 149. After removing bolts 150a, 150b and nuts 150c, 150d (similarly to first tru-vee openers 150), the farmer manually slides each third tru-vee opener 153 inwardly toward center frame center 149 by approximately three linear inches toward second tru-vee opener 152 within appropriate set 151. Drill nuts 120, washers 130, bolts 150a,

150b, and nuts 150c, 150d are then tightened in their new positions as with first tru-vee opener 150. First and third tru-vee openers 150, 153 within each set 151 are now each approximately seven inches apart from their corresponding central tru-vee opener 152.

5 ***Horizontal adjustment of seed drill row cover units 140***

(108) Referring now to Figures 12 and 15B (posterior view of seed drill 96), in both the prior art and my modified seed drill 96, each row cover unit 140 comprises two wheels 140a, 140b which connect to row cover unit frame 206. Each row cover unit 140 corresponds to a single tru-vee opener 150, 152 or 153 which is anterior to that row cover unit 140 (also in the prior art and my invention 110). Each row cover unit 140 also comprises a corresponding spring 170a which attaches row cover unit 140 to foot board 143.

(109) After adjusting tru-vee openers 150, 153 as discussed *supra*, the farmer removes drill nuts 140c, 140d, and 140e from each corresponding row cover unit 140. The farmer now slides each 15 row cover unit 140 directly posterior to a corresponding re-aligned tru-vee opener 150, 153 as the case may be. Each corresponding row cover unit 140 moves directly posterior to each opener 150 or 153. Drill nuts 140c, 140d, 140e are then tightened, thereby retaining each row cover unit 140 in its new horizontal position along row cover unit frame 206 and foot board 143.

20 (110) The farmer continues this procedure for each row cover unit 140 which corresponds to tru-vee opener 150 or 153. Tru-vee opener 152 in each set 151 within a set is not moved, so its corresponding row cover unit 140 is also left unchanged. As seen in Figure 13, this spacing avoids disturbance of corn seed 10 by placing three subrows 9a, 9b, 9c approximately midway within one 30-inch wide corn row 8.

25

(110) The seeding of three subrows 9a, 9b, 9c with soybean seeds 12 between consecutive corn rows 8 containing corn seed 10a, comprises the preferred embodiment and best mode of my

improved method 110. Method 110 produces a quick tilled intercropped strip in an east-west direction for optimal sun exposure, and is repeated as a one-step tilling and planting across each field as described *supra*. Three subrows 9a, 9b, 9c within consecutive 30-inch wide corn rows 8 also provides sufficient area and soil depth for both corn seed 10 and soybean seed 12 to mature, 5 while preventing soil 45 between adjacent soybean areas 9 from remaining unplanted.

(111) If modified in the above described manner, preferred seed drill 96 does not plant over previously or posterior seeded corn rows 8, because each set 151 of tru-vee openers 150, 152, 153 leaves consecutive unplanted soil 45 for corn seed 10 between adjacent sets 151. Please see

10 Figure 13. In sum, modified seed drill 520 seeds eight areas 9 of three soybean subrows 9a, 9b, 9c with alternating unplanted areas 8b (which are seeded by conventional corn planter 95 towed by tractor 97). Soybean seeds 12 are planted anterior to tractor 97, with one area 9 of subrows 9a, 9b, 9c always directly anterior to tractor center 97c.

15 (112) Other prior seed drills 96 are satisfactory for my method 110 in other modes, if they are adjustable for furrow depth and width, as well as row width. A 30-inch wide corn row 8 width comprising single straight furrows 90 results in uniform, 21-inch spacing of mature soybean plants 16 within corn row 8. Within each soybean area 9, soybean seeds 12 are planted at approximately eight (8) to twenty (20) seeds per square foot of soil 45. In other embodiments, the

20 farmer plants with first and second tractors 97. First tractor 97 pulls JOHN DEER 520 seed drill 96, as modified *supra*, and seed drill 96 plants three subrows 9a, 9b, 9c while second tractor 97 pulls attached prior art corn planter 95. The most common prior art spacing for corn rows 8 is approximately thirty inches, but row spacing can range from approximately fifteen to forty inches.

Mounting seed drill 96 to front end loader 200 and fork lift attachment 203

(113) The above modified seed drill 96 must be operatively attached to tractor anterior 97a. In the best mode and preferred embodiment (i.e., to intercrop corn seed 10 and soybean seed 12 in one pass) the farmer equips tractor anterior 97a with a prior art front end loader 200 and prior art

5 fork lift attachment 203.

(114) Referring to Figures 14 and 15A, front end loader 200 maintains proper alignment of modified seed drill 96 with tractor 97 and conventional corn planter 95 by connecting seed drill 96 rigidly to tractor anterior 97a through forks 202a, 202b. Front end loader 200 vertically raises and lowers this same modified seed drill 96, while seed drill 96 remains in the same rigid anterior position. Front end loader 200 and fork lift attachment 203 are centered upon tractor anterior 97a, so first horizontal side 96a of seed drill 96 is same length as second horizontal side 96b.

(115) Still referring to Figure 15A, the user mounts fork lift attachment 203 on set 151 which is immediately to the left or right of center support frame 149. In the appended figures, fork lift attachment 203 is mounted to right side 160b so that a single tru-vee opener 152 is directly anterior to tractor center 97c. In this manner the farmer can mount seed drill 96 to tractor 97 at one of two positions, as long as front end loader 200 is positioned upon one center set 151 of tru-vee openers 150, 152, 153.

20

(116) Still referring to Figure 15A, center support frame 149 is located in the center of seed drill 96, so tractor center 97c aligns with one tru-vee opener 152. One soybean subrow 9b is now planted directly anterior to tractor center 97c. However, it is necessary to offset center frame 149 from tractor center 97c, to plant soybean subrow 9a directly anterior to tractor center 97c.

25

(117) Referring to Figures 12B and 15A, the farmer mounts seed drill 96 upon prior art fork lift attachment 203 by first and second attached forks 202a, 202b respectively. Forks 202a, 202b are

attached to fork lift attachment 203, while attachment 203 is attached to front end loader 200. As seen in Figure 12A, first fork 202a fully opens outward from fork lift center 203a, while second fork 202b opens half-way from forklift center 203a. As seen in Figure 12, properly positioned forks 202a, 202b lie under row cover unit frame 206 and third frame 148, but rest upon tru-vee 5 opener frame 147.

(118) Referring to Figure 10, modified seed drill 96 comprises eight sets 151 of tru-vee openers 150, 152, 153 on each JOHN DEER 520 seed drill 96: (i) four on the first side of the tractor center 97c, one set 151 between forks 202a, 202b, see *infra*, and (ii) three sets 151 on the second 10 side of tractor center 97c. To balance seed drill 96, forks 202a, 202b each slide alongside three tru-vee openers 150, 152, 153 and center frame 149. As a result, one set 151 of tru-vee openers 150, 152, 153 fits between forks 202a, 202b after proper mounting of seed drill 96, *infra*. Please see Figures 12 and 15A.

15 (119) The preferred prior art front end loader 200 comprises first, second, third and fourth hydraulic cylinders 205a, 205b, 205c, 205d (generically 205) operated by an interior tractor oil pump. First and second hydraulic cylinders 205a, 205b respectively are positioned upon front end loader posterior 200b; they raise and lower front end loader 200 with fork lift attachment 203. The remaining third and fourth hydraulic cylinders 205c, 205d respectively pivot prior art retrofit 20 adapter 206 on front end loader anterior 200a by hooks 92.

(120) Still referring to Figure 12, retrofit adapter 206 fits within slots 46a on bars 46b within prior art fork lift attachment 203; retrofit adapter 206 connects fork lift attachment 203 to front end loader 200 (not seen in this view). Retrofit adapter 206 moves with hydraulic cylinders 205c, 25 205d whenever fork lift 203 is mounted to retrofit adapter 206, thereby pivoting fork lift attachment 203. This arrangement of adapter 206 with hydraulic cylinders 205c, 205d and fork

lift attachment 203 allows the farmer to level seed drill 96 when seed drill 96 is attached to forks 202a, 202b.

(121) Referring now to Figures 12A and 12B, to obtain the alignment described *supra*, the farmer 5 manually lifts first fork 202a from its initial fork slot 223a within fork lift attachment 203. He then moves fork 202a to its furthest position from fork 202b, to second fork slot 223b. He also moves fork 202b from fork slot 223c to fork slot 223d until it is approximately 30 inches from fork 202a. Fork 202a slides to its fully opened 24 inch length, while second fork 202b opens only half-open twelve inches from fork lift attachment center 203a.

10

(122) First fork 202a extends further than second fork 202b, because fork 202a slides adjacent to frame 149, and so it moves further than fork 202b from its original position. Each fork 202a, 202b moves approximately 24 inches for an approximately 48-inch horizontal interval with forks 202a, 202b fully open. Thirty inches is the horizontal interval necessary to fit tru-vee openers 150, 152, 153 and center frame 149 between forks 202a, 202b. Please see Figure 13. The half open position of fork 202b is approximately (i) ten inches from fork lift center 203a, (ii) ten inches from the exterior edge 203b of fork lift attachment 203; and (iii) thirty-four inches from exterior edge 203c. These measurements take into account that forks 202a, 202b are each approximately four inches wide and approximately 1½ inches thick.

20

(123) Prior to mounting seed drill 96 to fork lift 203, fork 202a must slide alongside center frame 149 on seed drill side 96a. As seen in Figure 15A one set 151 of tru-vee openers 150, 152, 153 respectively fits between forks 202a, 202b. The farmer then attaches forks 202a, 202b to opener draw bar 147 with first and second U-clamps 208a, 208b respectively. Prior art unmodified seed 25 drill 96 only deposits one row of soybean seeds 12 to the left and right of tractor center 97c. However, as seen in Figure 15A, in my invention 110 there are four sets 151 of three tru-vee openers 150, 152, 153 on either side of center support frame 149. Now the farmer can attach

modified seed drill 96 to fork lift 203, so one tru-vee opener 152 directly anterior to tractor center 97c.

(124) To mount seed drill 96 to fork lift 203, the farmer lifts hydraulic cylinder 205b, which is 5 located beneath and at the posterior of front end loader 200. He then lifts front end loader 200 until each fork 202a, 202b moves under row cover unit frame 206. The farmer pivots hydraulic cylinder 205a (located upon and anterior to front end loader 200) to level forks 202a, 202b so forks 202a, 202b can slide between third frame 148 and opener drawer bar 147. Forks 202a, 202b must be completely level, otherwise forks 202a, 202b will not slide between third frame 148 and 10 opener drawer bar 147.

(125) The farmer next drives tractor 97 forward to further slide forks 202a, 202b under third frame 148 and upon opener draw bar 147. Fork 202a slides alongside center frame 149 on first seed drill side 96a while fork 202b slides alongside tru-vee opener 153 on second seed drill side 15 96b. One set 151 of three tru-vee openers 150, 152, 153 are now located between fork 202b and center support frame 149.

(126) The farmer now places first and second ten inch U-clamp 208a, 208b respectively upon 20 each fork 202a, 202b respectively, as well as upon opener draw bar 147. He then tightens U-clamp nuts 42 with first and second U-clamp steel plates 41a, 41b between U-clamp nuts 42 and opener draw bar 147. Using hydraulic lift 205b (located upon posterior 203b of fork lift attachment 203) the farmer lowers seed drill 96 to disperse soybean seeds 12. He elevates seed drill 96 at the end of a soybean area 9 or when otherwise transporting seed drill 96.

25 (127) A John Deere 541 Series Loader 200 with attached fork lift 203 is the preferred front end loader and forklift of choice. However other front end loaders 200 and fork lifts 203 are satisfactory, depending upon compatibility with a farmer's equipment. As seen in Figure 13, front

end loader 200 pushes seed drill 96 while corn planter 95 follows behind tractor 97 and linearly deposits corn 10 within corn furrows 90. Referring to Figure 14, in the best mode the farmer attaches corn planter 95 to tractor 97 posterior, using a three point hitch 230a or a one point tug hitch 230b, both of which are familiar to the agricultural industry.

5

(128) With a conventional front end loader 200 and a coupled conventional fork lift 203, a farmer intercrops at least two plants simultaneously, thereby saving time, machine fuel and labor. In other modes modified seed drill 96 is towed by a first tractor 97 with attached corn planter 95, and which closely follows modified seed drill 96. Whether seed drill 96 or corn planter 95

10 proceeds the other is not crucial, if no significant time passes between corn and soybean seedings.

Attached corn planter 95

(129) Referring to Figure 11, the farmer plants corn seeds 10 linearly within furrows 90 with a prior art mechanical corn planter 95 (preferably a KINZIE 3100 corn planter). Each corn planter 95 has row units 162 which open soil to create corresponding corn furrows 90. Each row unit 162 also places corn seed 10 within its corresponding corn furrow 90. As corn planter 95 moves forward, each corresponding row cover unit 162a covers its furrow 90 with soil 45.

(130) Referring to Figure 14, there are eight row units 162 (not all seen in this view) which

20 horizontally align upon prior art corn planter 95, with corn planter 95 posteriorly attached to tractor 97. Each row unit 162 mechanically opens each furrow 90 and deposits corn seed 10a. Corn planter row units 162 are adjustable for linear intervals of seed deposit location, as well as seeding to a pre-determined depth. With my method 110, each row unit 162 deposits a corn seed 10a every eight linear inches, while row cover unit 162a then covers seeds 10 with soil 45.

25

(131) After the farmer has intercropped and applied combination mulch 20 (described *infra*) to the first twenty-foot wide area of soil 45, he tills soil 45 and combination green manure 44 for an

additional eight corn rows 8 (i.e, another approximate twenty feet lateral width) adjacent to the preceding intercropped twenty-foot wide area. This incremental process continues for each twenty-foot wide pass comprising eight consecutive furrows 90 which are separated by 30-inch corn row 8. In the best mode the operator uses a JOHN DEERE 520 seed drill 96 with a twenty-
5 foot plant path width, and an unmodified prior art corn planter 95 with an approximate twenty-foot pass width. However, if the operator uses a four row corn planter 95, he only tills that much soil 45 within four corn rows 8 of one pass.

(132) Other means of intercropping commercial plants are also within the scope of my invention
10 for larger commercial fields. For small gardens, the farmer uses a conventional manual leaf rake 99 to distribute soybean seed 12 randomly within each approximately twenty- inch wide soybean area 9. With either the manual method or mechanized approach, soybean seeds 12 are planted approximately two to three inches deep into soil 45.

15 **Production and Application of Combination Mulch 20**

Introduction

(133) In the best mode mowed green manure plants 44a, corn stalks 5 and other organic debris 19 remaining after the fall harvest are collected similarly to conventional forage: A forage feed harvester harvests and blows mowed green manure plants 44a and debris 19 into forage wagon
20 51. Please see Figure 18. In my invention 110, initial blending of combination mulch 20 results from mowing and blowing of severed green manure plants 44a and debris 19 into forage wagon 51.

(134) Prior art bale chopper 108 chops organic debris 19 over soil 45, along with corn stalks 5,
25 soybean stems and mowed green manure plants 44a (preferably wheat grass 18a) as combination mulch 20. Several seconds is the ideal maximum time interval between procedures for seeding

and mulching during method 110. However, a time interval of no more than approximately two hours between seeding and mulching a twenty foot pass width is satisfactory.

(135) Referring now to Figures 17 and 19, the GOOSEN bale chopper is the preferred bale

5 chopper 108, and it is available from:

Goosen Industries

P.O. Box 705

Beatrice, Nebraska 68310

10 1-800-228-6542;

1-402-228-4226

(136) The preferred prior art forage box wagons 51 for temporarily storing large amounts of

combined chopped mowed wheat grass 18a and organic debris 19 is available from:

H&S Manufacturing Co.,Inc.

15 2608 South Hume Avenue

P.O. Box 768

Telephone: 1-715-387-3414

Marshfield, Wisconsin 54449

Models: HD7+4 & HD Twin Auger;

20 HD7+4 HDTwin Auger-front and rear unload; and

power box-rear unload

(137) For smaller amounts of wheat grass 18a and organic debris 19, preferred Versa Vac storage box

wagons (conventionally used for grass clippings and leaf pick-up) are available from:

25

Fuerst Brothers, Inc.

P.O. Box 427

Gibson City, Il.

1-800-435-9630,

Models: M180G,M500P,M500G,M900P,M900G.

Fuerst Manure Spreaders are also satisfactory and are distributed by:

5 H.F.S. Tractor

1218 South 11th Street

Niles, Michigan

1-616-683-7272

(138) Unload augers 215a, 215b and discharge opening 137 comprise a cover or lid in the prior

10 art. Attachment of conventional forage box wagons 51 to forage harvesters is already routine for harvest and storage of forage feed. However, my method 110 introduces a new manner to produce combined mulch 20 from green manure 44 and organic debris 19 in forage box wagon

51. In this process, the farmer operatively attaches bale chopper 108 to the side of forage box wagon 51 around first and second unload augers 215a, 215b respectively, *infra*. My method 110

15 eliminates manual labor for filling bale chopper 108 in the prior art. In addition, my remounted pipe 230a and hose 230b spray combination mulch 20 over the intercropped seeded field in a manner well known in this agricultural industry. Please see Figure 16.

Mounting bale chopper 108 and extension hose 203 to forage box wage 51

20 (139) Prior to intercropping the farmer attaches preferred gasoline powered prior art bale chopper 108 to forage box wagon 51. First and second unload augers 215a, 215b respectively are located within discharge opening 137 along the anterior lateral exterior surface of forage box wagon 51.

Please see Figures 17, 18. On either side of each first and second unload auger 215a, 215b are rear extension panel st17 and anterior extension panel st18 respectively. Power take off (PTO)

25 165 is a prior art drive shaft at tractor posterior 97e which connects to a second drive shaft on

forage wagon 51. When functionally connected, PTO 165 transfers power from tractor 97 to forage wagon 51 to operate both unload augers 215a, 215b.

(140) In my invention 110, organic debris 19 and green manure plants 44a are pulled from prior art forage wagon 51, through rotating augers 215a, 215b and beaters 36 located above augers 215a, 215b. Using prior art t-rod slats attached to chains (not seen) on the floor of forage wagon 51, green manure 44 is pulled to the forage wagon anterior. Rotating unload augers 215a, 215b propel debris 19 and green manure plants 44a through discharge opening 137 into bale chopper 108, while plastic guard 169 protects the farmer from injury during operation.

10

(141) Referring now to Figure 19, unload augers 215a, 215b do not physically connect to bale chopper 108 in any manner. Instead, blended debris 19 and green manure plants 44a move through discharge opening 137 around augers 215a, 215b and then into bale tube 76, prior to entering bale chopper main frame 130. Bale tube 76 holds organic debris 19 and green manure plants 44a, until main frame knife blades 175a rotate and chop debris 19 and plants 44a, thereby creating combination mulch 20.

(142) As best seen in Figure 17, front and posterior panels st17, st18 respectively form first and second parallel walls of discharge opening 137. To attach bale chopper 108 to discharge opening 147, the farmer slides bale chopper 108 along panel st17, st18 exterior surfaces until interior surfaces of bale tube 76 snugly fit over exterior surfaces of panes st17, st18. The farmer next drills two $\frac{1}{2}$ inch diameter circular apertures 240a, 240b (using a conventional power drill and a $\frac{1}{2}$ inch drill bit) through anterior edges 17a, 18a of each corresponding extension panel st17, st18. Each pair of apertures 240a, 240b is located approximately four inches above the bottom of either extension panel st17, st18. He also drills similar apertures 241a, 241b through both posterior edges 76a, 76b of bale tube 76.

(143) The farmer then places a first two-inch long by $\frac{1}{2}$ inch thick auger bolts 225a through apertures 240a, 241a and an identical second bolt 225b through 240b, 241b respectively. He then tightens auger bolts 225a, 225b in place by prior art washers and nuts (not seen). In this manner, he attaches bale chopper 108 to each front and rear extension panel st18, rear st17 with 5 first and second auger bolts 225a, 225b (i.e., two auger bolts 225 along each corresponding anterior edge 18a, 17a respectively of each front extension panel st18 and rear extension panel st17 respectively)

(144) Still referring to Figures 17, 19 and 20, the farmer attaches one first and one second main 10 frame L-bracket 220a, 220b respectively to first side stack st8 and second side stack st9 respectively. There are at least four self-taping screws 242 for attachment of each L-bracket 220a, 220b to side stack st8 and side stack st9. Each L-bracket 220a, 220b is preferably twelve-inches in length by one inch in width, and each self-taping screw 242 is approximately 3/8 inch wide by $\frac{1}{2}$ inch-long. L-brackets 220a, 220b attach to both bale chopper main frame 130 and the 15 side of forage box wagon 51 with bale chopper 108.

(145) As seen in Figures 17 and 19, the farmer must elevate bail chopper 108 so that bale tube 76 snugly encloses front and posterior panels st17, st18 prior to bolt 225a, 225b and L-bracket placement 220a, 220b. Because this bolt and bracket placement requires several hours, a platform 20 for mounting bale chopper 108 is recommended. Preferably, the farmer places bale chopper 108 upon two wood blocks 109a, 109b until bale chopper 108 is attached by brackets 220a, 220b and bolts 225a, 225b to forage wagon 51.

Attachment of hose 230b and spray of combination mulch 20

(146) Referring to Figures 19 and 20, the farmer uses four conventional bunge straps 229 to 25 physically attach exhaust hose 230b, by hooking bunge straps 229 to first and second side stacks st7, st8 respectively, as well as third and four side stacks st10,st11 along forage wagon 51. Pipe

230a connects bale chopper 108 to hose 230b in a manner well known in this art. Preferably hose 203b is trimmed to spray combination mulch 20 over soil 45.

(147) In smaller fields or gardens, implements such as the 109 BLUEBIRD™ EasyRake to 5 collect and preferably distribute a smaller quantity of combination mulch 20 over soil 45. The farmer then manually plants and seeds soil 45 within an area of approximately ten to 20 feet in width. The farmer can then follow seeding with application of combination mulch 20 in the smaller field or garden.

(148) The BLUEBIRD™ EasyRake is available from:

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BlueBird International, Inc.

1400 East 66th Avenue

Denver, Colorado 80229 U.S.A.

Phone: 1-303-288-5880; 1-800-808-BIRD

15 **Timetable and schedule for planting**

(149) The best mode and preferred embodiment for the spring planting schedule for my combined intercropping and mulching method 110 is as follows:

(a) During early May, the planter checks soil 45 to ensure a minimum soil temperature of 60 degrees F. Also at this time, the planter checks soil nutrients, by using a soil test kit well known

20 in the industry. Such a kit is Rapitest Soil Test Kit No. 1601, which is available from:

Luster Leaf Products, Inc.

2220 Techcourt

Woodstock Il. 60098

25 Phone: 1-800-327-5567

(150) (b) Also early in May of the same growing season, green manure plants 44a and organic crop debris 19 are mowed and raked. One portion of combined green manure 44 (i.e., green manure plants and organic crop debris 19) is briefly stored for combination mulch 20, as described supra. In the best mode wheat grass 18a and/or buckwheat 17 comprising green manure 44 are 5 cut approximately three to ten inches above soil 45.

(i) approximately one/half of combination green manure 44 and organic residue 19 is tilled approximately four inches into soil 45.

(ii) the farmer then tills soil 45 and organic residue 19 to a depth of approximately nine to 14 inches in large commercial fields and approximately four to nine inches in depth in a garden.

10 He then immediately seeds corn 10 and soybeans 12, covers them with soil 45, and lastly covers the soil with combination mulch 20 to approximately 1/2 inch in depth.

(151) Combination mulch 20 diminishes soil heat loss and also absorbs solar warmth at this point in the growing cycle when the air temperature is still cool. There is also heat created by bacterial 15 and fungal decomposition of combined green manure 44 within soil 45, as well as diminished sun-bleached soil.

(152) (c) First week after seeding and mulching: Corn seedlings 10b and soybean seedlings 14 sprout, due to increase in moisture and heat from combination mulch 20. There is also solar heat 20 from combination mulch 20 and retention of moist heat from above surface combination mulch 20.

(153) (d) Second week after seeding: Corn seedlings 10b and soybean seedlings 14 compete for space and create a leaf canopy 30. Nitrogen fixing soybean root nodules 18 first appear.

(154) (e) Third week after seeding: Maturing corn plants 10c are approximately 14 inches in height. Soybean corn leaf canopy 30 begins to shade soil 45, thus discouraging sprouting weeds 62. Most soybean root nodules 18 now are clearly visible.

5 (155) (g) Fourth week after seeding: Maturing corn plants 10c are now approximately 30 inches in height and maturing soybean plants 16 are approximately 23 inches in height. Weeds 62 continue to weaken from light deprivation. Soybean and corn plants 10c, 16 respectively quickly fill space with available sunlight.

10 (156) (h) Sixth week after seeding: Corn roots 25 now physically contact soybean roots 17. Corn plants 10c turn from a glossy light green to a darker green color, while corn roots 25 continue to elongate and contact soybean roots 17. Soybean pods 18 appear in approximately mid-July.

15 (157) (i) Seventh week after seeding: Corn roots 25 continue to elongate towards soybean roots 17. Both soybean roots 17 and corn roots 25 intertwine to form a physically massive root system 25a. Meanwhile, leaf canopy 30 assists in retention of moisture within soil 45. Leaf canopy 30 also prevents the sun from cracking and bleaching topsoil 45a.

20 (158) (j) Eighth week after seeding: Sporadic weeds 62 grow through corn and soybean leaf canopy 30. However, they generally remain stunted and close to topsoil 45a. Surviving smartweed diminishes Japanese beetle consumption of maturing soybean plants 16 and maturing corn plants 10c.

25 (159) Planted in the above manner and according to the above timetable/schedule, maturing corn plants 10c and soybean plants 16 more effectively resist near-drought conditions with a topsoil temperature of approximately 80 degrees (Fahrenheit) F. Intertwining root system 25a retains moisture by reducing evaporation and erosion.

(160) Unlike my mulch treated intercropped topsoil 45a, topsoil of conventional single crop fields generally acquires an approximate 1/8 inch sun bleached crust during summer months. Moreover, conventional single crop fields remain desiccated from approximately one to three inches into soil 5 by August during typically dry midwestern summers. In fact, summer soil temperatures in these single crop fields routinely reach a temperature of at least approximately 100 degrees F.

(161) My intertwining root system 25a, even after an early frost, remains physically intact and retains soil and nutrients during winter months. Intertwining root system 25a also resists erosion

10 from wind, snow and rain, thereby preventing soil losses of bare conventional winter fields. Hundreds of corn roots 25 and soybean roots 25 demonstrate intertwining root systems 25a, and reveal more roots 25 on the side of corn plants 10c which are physically closest to soybean plants 16. Moreover, corn plant roots 25 are longer on sides closest to soybean plants 16. Corn plant roots 25 also quickly attach to organic debris 19 tilled into soil.

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Windbreaking and microclimate 31

(162) Each intercropped corn row 8 comprising linearly aligned corn plants 5 exhibits a windbreaking effect on shorter proximate soybean plants 16 (from approximately the first two feet of maturing soybean plant 16 height). Each intercropped row/area 9 of soybean plants 16 also 20 has its own windbreaking effect on lower cornstalks 5. All these windbreaking effects prevent wind from desiccating and blowing topsoil 45a.

(163) Examples of conventional windbreaks include a fence of appropriate height and permeability, as well as treelines. These windbreaks should be approximately 50 percent 25 permeable and have a windbreaking effect up to six times the height of the particular plant. A permeable fence allows at least 50% of prevailing wind to pass through of its structure, and consequently it slows and does not stop the wind. My combined intercropping and mulching

process 101 differs from artificial windbreaks, because each corn row 8 is itself an effective windbreak feature. In fact, each linear arrangement of corn within its corn row 8 exhibits a windbreaking effect on crops of approximately six times the height of an average corn plant 10c. However, corn plants 10c must be planted linearly as in corn rows 8, and they must be 5 intercropped with plants such as soybeans 16 or buckwheat 18.

Moisture Retention

(164) Corn leaves 19 are physically shaped as moisture collectors, as are soybean leaves 26. Corn leaves 19 collect water drops which flow to lower soybean leaves. Or, moisture such as rain or 10 dew collecting within corn leaves 19 gutters to leaf pockets and then directly to topsoil 45. Soybean leaves 26 recollect water dropped from corn leaves 19 and gutter to topsoil 45a in a similar manner. This moisture collection aids artificial irrigation by forming tiny streams which drain directly to the soil lying beneath leaf canopy 20. This process occurs shortly after soybean seeds 12 and corn seeds 10 sprout approximately two weeks after seeding. By the third week after 15 seeding (planting), there is a full effect before the summer growing, when water generally becomes more scarce, particular in treeless fields.

(165) Microclimate 31 of my combined intercropping and mulching process 110 also creates, between topsoil 45a and leaf canopy 30, a zone of diminished air movement and low light 20 intensity. Artificial fertilizers are unnecessary in this best mode and preferred embodiment of my combined mulching and intercropping process 110. However, in other embodiments the planter can apply fertilizer uniformly throughout the soil to a depth of approximately eight inches, in a concentric manner around each row 8, 9 of plants 10c, 16.

25 Harvesting the commercial crop

(166) Mature soybean pods 20 are harvested during October or November, which is after corn ears are harvested, and the soybean pods 20 attain sufficient moisture. Subsequently, corn ears

continue to dry in the field. In late October or early November, corn ears are harvested by a conventional combine, which is well known in the agricultural industry.

(167) As seen *supra*, my improved combined intercropping and mulch process 110 allows corn

5 harvests with different crop combinations. However the drying times of different crop species varies, as does crop and weather moisture content between growing seasons. Therefore, the planter should make an individualized decision each year, as to exactly when to harvest the commercial corn and soybean crops. Such re-evaluation diminishes losses from leaving crops in the field an overly long time.

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(168) My improved intercropping and mulching method 110 seeds at least two commercial crops simultaneously. The time interval for maturation of both corn 10a and soybeans 12 is approximately one hundred days. My generic method requires that soil 45 be tilled evenly and blended with combined green manure 44. In addition, legumes are a requirement for all my

15 intercropped fields as at least one commercial crop.

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